Proceedings of the 2012 AAAS Charles Valentine Riley Memorial Lecture

# Why Innovation in Agriculture Matters

Co-sponsored by the Charles Valentine Riley Memorial Foundation
in collaboration with the World Food Prize Foundation

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AAAS

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# Foreword

One of the central themes of the 2012 AAAS Charles Valentine Riley Memorial Lecture was the urgent need for cooperation and collaboration—among the public and private sectors; among agricultural scientists/researchers and practitioners; and among partners at the local, national and international level—toward solutions to the enormous agriculture-based challenges we face as a society.

Indeed, addressing the many issues that jeopardize our planet—like feeding the more than 7 billion people who now inhabit the Earth in consistent and sustainable ways— will necessitate a coordinated, global approach. With limits on the amount of arable farmland and water available, feeding so many people will require innovative farming techniques that greatly increase productivity without detrimental environmental impacts.

Many regions continue to suffer from limited food production and availability, which lead to chronic hunger, malnutrition, and the constant threat of famine. These are global problems that should be of concern to everyone, not just the individuals directly affected. And agricultural research and innovation will continue to be critical pieces of this enormous puzzle.

The notion of promoting agriculture and agricultural research as a most basic human endeavor was at the core of Charles Valentine Riley's beliefs, and the foundation for the creation of the Charles Valentine Riley Memorial Lecture at the American Association for the Advancement of Science (AAAS). Our colleagues at the Charles Valentine Riley Memorial Foundation and the World Food Prize Foundation continue to help us find ways to broaden our focus in agricultural research and the contribution we can make to these discussions. We thank them for their valuable input and we remain grateful to them—and to our sponsors—for their continued support.

On the pages that follow, you will find the text of the 2012 AAAS Charles Valentine Riley Memorial Lecture as well as an excerpt from the *AAAS Report XXXVII: Research and Development FY 2013,* which examines resources devoted to research and development related to food, nutrition, agriculture and natural resources in the federal budget. I hope you will find this information interesting and useful.

While the challenges are immense, we have confidence in the abilities of our researchers to find solutions and in our policy makers to implement the changes necessary so that current and future generations will have the opportunity to benefit and thrive.

Alan I. Leshner
Chief Executive Officer, AAAS and
Executive Publisher, *Science*

# Acknowledgements

This year's lecturer was chosen by a distinguished Selection Committee. We would like to thank the committee members for their efforts:

**Daniel Bush**
Professor and Vice Provost for Faculty Affairs, Colorado State University

**Ambassador Kenneth Quinn**
President, The World Food Prize Foundation

**Richard Ridgway**
President, The Charles Valentine Riley Memorial Foundation

**Vaughan Turekian**
Chief International Officer, AAAS

We would also like to recognize and thank the following sponsors for their generous support of this year's lecture:

Charles Valentine Riley Memorial Foundation

Agricultural Research Service

ERS Economic Research Service

National Institute of Food and Agriculture

CASE IH Agriculture

DuPont

Mars Incorporated

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# Participant Bios

**Rob Horsch** is Deputy Director for Research & Development in the Agricultural Development Program at the Bill & Melinda Gates Foundation. Prior to his current role, he was a Senior Program Officer from 2006 to 2008. He was previously employed by Monsanto where he served as Vice President of Product and Technology Cooperation, with the responsibility to help small-holder farmers in developing countries gain access to better agricultural products and technologies. He is a leader in the effort to create agricultural technologies that help improve yields and incomes for farmers around the world, and has launched programs to transfer and apply such technologies to developing country applications, train and help educate scientists around the world, and communicate the science, benefits, and risks of agricultural biotechnology in the context of global sustainability and sustainable development. He was awarded the 1998 National Medal of Technology by President Clinton for contributions to the development of agricultural biotechnology. Dr. Horsch received his Ph.D. in genetics at the University of California, Riverside and conducted postdoctoral work in plant physiology at the University of Saskatchewan in Canada.

**Bill Northey** is currently serving his second term as Iowa Secretary of Agriculture. Throughout his career in agriculture, he has been a leader in a variety of farm groups, including the National Corn Growers Association, where he served terms as President and Chairman. Secretary Northey has also served on the Iowa USDA Farm Service Agency State Committee, was a Dickinson County Soil and Water Conservation District Commissioner and was a Board member of Ag Ventures Alliance. He is also a fourth-generation farmer from Spirit Lake, Iowa, who grows corn and soybeans. Secretary Northey graduated from Iowa State University with a degree in agricultural business and holds a Masters in Business Administration from Southwest Minnesota State University.

**Steven G. Pueppke** is Director of AgBioResearch and is the Associate Vice President for the Office of the Vice President for Research and Graduate Studies at Michigan State University (MSU). He works to translate MSU's land-grant roots and values into a strong, vibrant foundation of research and technology transfer to promote economic development in Michigan. He came to the University in 2005 from the University of Illinois, where he had been Associate Dean for Research in the College of Agricultural, Consumer and Environmental Sciences since 1998. He was formerly a member of the Advisory Committee on Biotechnology and 21st Century Agriculture (AC21) of the USDA, where he helped examine the long-term impacts of biotechnology on the U.S. food and agriculture system and guided the USDA on issues related to the application of biotechnology in agriculture. He received his undergraduate degree in horticulture from MSU and a Ph.D. in plant pathology from Cornell University.

**Catherine Woteki** is Under Secretary for the USDA's Research, Education, and Economics (REE) mission area, as well as the Department's Chief Scientist. Her responsibilities include oversight of the four agencies that comprise REE-Agricultural Research Service, Economic Research Service, National Institute of Food and Agriculture, and National Agriculture Statistics Service. The National Agriculture Library and National Arboretum also fall under this mission area. Before joining USDA, Dr. Woteki served as Global Director of Scientific Affairs for Mars, Incorporated, where she managed the company's scientific policy and research on matters of health, nutrition, and food safety. Prior to being at Mars, she was the Dean of the College of Agriculture and Life Sciences at Iowa State University, and she was the first Under Secretary for Food Safety at USDA from 1997 to 2001. She received her M.S. and Ph.D. in human nutrition from Virginia Polytechnic Institute and State University, respectively, and her B.S. in biology and chemistry from Mary Washington College.

# Lecture and Panel Discussion Summary

"Agricultural innovation matters to small-holder farmers, it matters to poor consumers, and it matters to us," said Rob Horsch, Deputy Director for Research and Development in the Agricultural Development Program at the Bill & Melinda Gates Foundation, during the 2012 AAAS Charles Valentine Riley Lecture. He went on to say that in the last century, one of the strongest drivers of poverty reduction has been agricultural innovation bringing down the cost of food. He stressed that once food becomes available and affordable enough, family resources are freed up for other basic needs and "they move from a survival mode to a development mode."

Horsch noted that three quarters of the world's poorest people live in rural areas and half of them are farmers. A typical farmer is a woman who is living on less than a dollar a day and growing several crops on one-half to one whole hectare (10,000 square meters) with no mechanization. By using better land management practices, he said, the typical small farmer in a developing country could see his or her land's output triple or more. Such dramatic improvements already have come for U.S. farmers, Horsch said, "because they're already way high on the curve" of adopting new technology. But for farmers using low productivity tools—such as poor quality seeds—and giving little or no attention to soil health, "it's relatively simple to make a huge increase…"

He also raised the issue that farmers who are poor also are consumers who are poor. While they want to benefit from selling food at higher prices, they also would like to buy food at lower prices. "There's actually a win-win approach, and it's called productivity," he said, citing the Green Revolution in Asia as an example of a time when productivity increased faster than prices decreased, thus allowing farmers to keep the difference.

Horsch noted that driving productivity in a win-win situation where both farmers and consumers are better off is a key component of the Gates Foundation strategy. He said the Foundation is focusing on three major outcomes of agricultural research and development: improved productivity of crops and livestock, decreased risk to farmers, and fostering improved nutrition— specifically vitamin A, zinc and iron enhancements— in staple crops. He concluded his remarks with examples of recent and ongoing projects the Foundation is leading and their partnerships with scientific organizations around the world and urged all stakeholders to look beyond our borders toward the promise of international cooperative research.

After the lecture, Catherine Woteki, Under Secretary for Research, Education, and Economics at the USDA, moderated a panel discussion with Bill Northey, Iowa Secretary of Agriculture; Steven Pueppke, Director of Michigan State University's AgBioResearch; and Rob Horsch.

Dr. Woteki led off the discussion by asking the panelists what they believed the roles of the federal government and the public and private sectors should be in agriculture research and development. Horsch offered that the U.S. has traditionally led the world when it comes to basic plant science, though decreased public investment in research is threatening that position. Northey advocated for increasing public investment in basic agricultural research, while also recognizing that collaboration across sectors often produces the greatest result. "When budgets are crazy-tight, everybody says, 'If it can be done privately, it needs to be done privately,'" he said. "Yet there are some things that must be done publicly."

Pueppke stressed the importance of raising the status of agriculture science as a legitimate and important scientific effort in order to attract the best students and increase resources for the field. "The real issues are the broader societal understanding of what we do and the different ways that we do it," he noted. "We often are very narrow when we advocate for agriculture research. We advocate by commodity or we advocate by state or we advocate by the kind of science we do and, at the end of the day, I think we confuse…our political leaders…" and the broader public. "We really need to work out ways [to] raise the water and … raise all boats. There are some organizations out there that are attempting to do that and they are so very, very important."

# Why Innovation in Agriculture Matters

**Rob Horsch**
Deputy Director for Research & Development, Agricultural Development Program,
Bill & Melinda Gates Foundation

It is an honor and pleasure to be here, and I very much appreciate the invitation. It's delightful to see so many old friends in the audience today who remind me of the trajectory my experiences have taken. I started my science career at a U.S. land-grant college in California where I became interested in basic biology, then focused on plant science in particular. I went on to do post-doctoral research in plant physiology in Canada before going to work for a corporation. It was through a National Science Foundation summer student program at the University of California, Riverside, when I was still in high school, that I became interested in science in the first place.

I started in basic plant science research and, even though I worked in industry, I was able to publish my results and to serve as a reviewer and on the editorial boards of several scientific journals. I also worked with the competitive grants programs of the National Science Foundation and the U.S. Department of Energy. Those service opportunities shaped my understanding of science and interest in its application by giving me a chance to look broadly at scientific research, beyond the niche that I was working in. After progressing from basic research to product development using the new tools of biotechnology in U.S. agriculture, I became interested in international development applications of biotechnology. Over the course of a decade, I learned about appropriate applications of both biotech and a broad set of agricultural tools in developing countries. About six years ago, that interest led me to join the Bill & Melinda Gates Foundation, when the Gates Foundation Agricultural Development Program was launched.

Before I explain why innovation in agriculture matters, let me preface with whom it matters, because that is fundamental to the focus of the Foundation's agricultural program. Agricultural innovation matters to small-holder farmers, it matters to poor consumers, and it matters to us. The Gates family and the employees at the Gates Foundation share a set of values, the foremost of these is the belief that all lives, no matter where they are being led, have equal value and that everyone should have the opportunity to lead a healthy and productive life. Honoring and actualizing that belief is what has led to the kinds of research, development and delivery programs the Foundation has chosen to support.

The Foundation started by investing in global health because Bill and Melinda realized what a significant immediate impact could be made with vaccines. This was something inexpensive, on a per-person basis, where a simple intervention could make lifesaving cures. Smallpox was eradicated in this way and polio is the next target for eradication and is a primary focus of the Foundation. This high leverage ability to use science and technology to touch people's lives with a great and lasting benefit was an impetus behind the Foundation's expansion. There is a strong connection between

infectious diseases, the immune system, health and the nutritional inputs which are dependent on agriculture. This understanding led to the initiation of the Foundation's Agricultural Development Program.

The Agricultural Development Program has projects in sanitation, nutrition, agriculture, libraries and financial services. In his annual letter this year, Bill Gates focused on the importance of innovation in agriculture and agricultural development, saying, "If you care about the poor, you care about agriculture." Three-quarters of the world's poor live in rural areas, and most of them are farmers. That innovation in agriculture leads to increased productivity, matters to farmers, but it matters even more to consumers because it leads to reducing the real cost of food. In the last century, one of the strongest drivers of poverty reduction has been agricultural innovation bringing down the cost of food. This is because people spending eighty percent of their income on food have little left over for their other important needs. Without sufficient calories and adequate nutrition, one does not live long enough to worry about one's other needs. Once food becomes available and affordable enough, family resources are freed up for other basic needs and they move from a survival mode to a development mode.

The trend in real prices of cereal over the last sixty years shows a long, slow decline due to productivity increases resulting from the application of science and technology to agricultural problems. Somewhere around the turn of the millennium, this trend may have gone through an inflection point, though it is still too early to know. However, with the dramatic food price spikes of 2008, which caught the world's attention, there is growing concern that the long-term trend of food prices has reversed from its downward progress, and is on the rise. While agricultural productivity has continued to rise, the rate of improvement has decreased along with the decline in investment in agricultural research and development. Total overseas development assistance has increased over the last forty years, but the level of assistance devoted to agriculture has declined. It is a strong correlation. Logic suggests these declines in investment and rate of progress are related—less investment, less progress, lower productivity rates of gain. Meanwhile, the world is growing, the population is increasing, and incomes are increasing. The demand on the food system is increasing. Demand is exceeding supply, and food prices are rising.

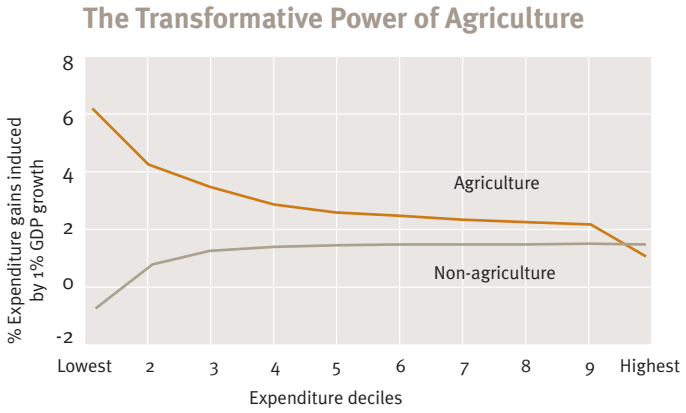
In the U.S. and other developed countries, there has actually been an increase in the rate of productivity gain due to very large investments in major crops research by companies like Pioneer, DuPont, Syngenta, and Monsanto. Crop breeding benefits from a large integrated effort; in this context a lot of little efforts do not add up to a big effort. The scale and sophistication of breeding with the use of molecular markers and genomic selection has increased the rate of progress in the private sector. However, the public sector is still largely diffused and dispersed, lacking in scale, sophistication and collaboration compared to the private sector. There has been controversy about the disparity between the large private investment and small public investment. The obvious solution is to increase public investment. Incidentally, this imbalance was a factor in my career shift from the private sector to a nonprofit.

There are a couple of dilemmas that complicate agricultural development. One is that farmers want high prices while consumers want low prices. This dilemma has led to problems as policymakers have tried to resolve it with crude interventions. A second dilemma is that the poorest farmers, the ones that we are trying to help at the Gates Foundation, are also impoverished consumers. The conflict is that as agricultural producers they want high prices, while as consumers they benefit from lower prices. Currently, the poorest farmers are net purchasers of food which means they are going to benefit from low prices, but our intent is for them to become net producers, in which case they benefit from high prices. There actually is a win-win approach to reconciling this dilemma—improving productivity. The Green Revolution in Asia benefitted so many people because productivity rose faster than prices fell, so farmers retained some of the benefit of the productivity increase, even though most of it flowed to consumers. This is essentially the strategy that we, at the Foundation, are trying to pursue: Driving productivity in a win-win situation where both farmers and consumers are better off at the end of the day.

Today, we must address environmental sustainability issues that were not fully appreciated during the early days of the Green Revolution. Such externalities are now being factored into agricultural prices which will shift the economic impacts of various practices. We want to be on the anticipatory side of those changes.

This World Bank chart shows that if growth is agriculturally driven, the poor benefit the most, while they benefit the least if growth is non-agriculturally driven.

In India, poverty declined from 60% to 40% over the Green Revolution period. That is a dramatic poverty reduction that can be directly attributed to increased agricultural productivity. The theory that we are following is that this same trajectory can be predicted in Africa. For given levels of



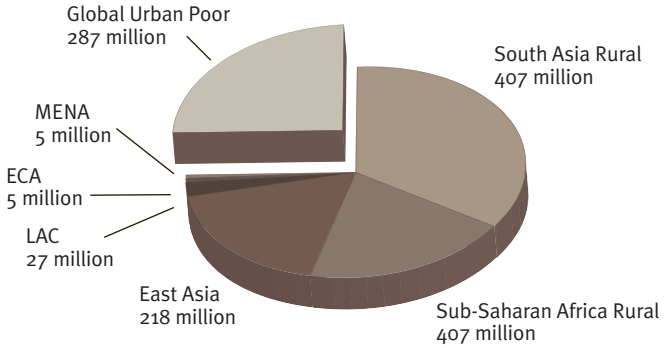

Ligon and Sadoulet 2007, cited in: World Bank (2007) World Development Report 2008: *Agriculture for Development* (World Bank, Washington, D.C.)

productivity increases, we can predict how much poverty reduction is expected. We are targeting something in the range of 150 to 200 percent productivity improvement in Africa, which we expect will about cut poverty in half. Over the last fifty years, there has been a huge gain in productivity in most of the world, but Africa has lagged far behind.

As food prices decline due to increased agricultural productivity, all consumers eventually benefit, including poor farmers who consume more food than they produce. However, farmers with a surplus harvest benefit only if their own productivity goes up enough to compensate for the lower price they get for the food they sell. Three-quarters of the poorest people on earth live in rural areas, and far more than half of them are farmers. Regarding its primary goal of reducing hunger and poverty, the UN Millennium Development Goal Hunger Task Force concluded that the best way to benefit the majority of these poorest people is through increasing their agricultural productivity. It also identified these as the most important levers to accomplish that goal: soil fertility, better water management, quality seeds, farm diversification, and effective extension services. Having the privilege of serving on that task force was a rare opportunity to contribute to something much bigger than my own work, and I learned a huge amount in the process. It was an invaluable experience of the power of collaboration, which is one of the Riley Foundation key values.

This Hunger Task Force Report chart shows that about three-quarters of the world's poorest people live in rural areas. The largest numbers are in Asia, but the biggest percentage is in Sub-Saharan Africa. A typical farmer lives on less than a dollar a day and grows several crops on one-half to one hectare of land. Without mechanization, this is full-time work, and a year-round effort, for these farmers. Most of these small-holder farmers are women who have gender-specific needs and circumstances that historically have not been well addressed by outreach efforts.

**Global Extreme Poverty, 2002, $1.08 day**




UN Millennium Project (2005) *Halving Hunger: It can be done* (Millennium Task Force on Hunger, Washington, D.C.)

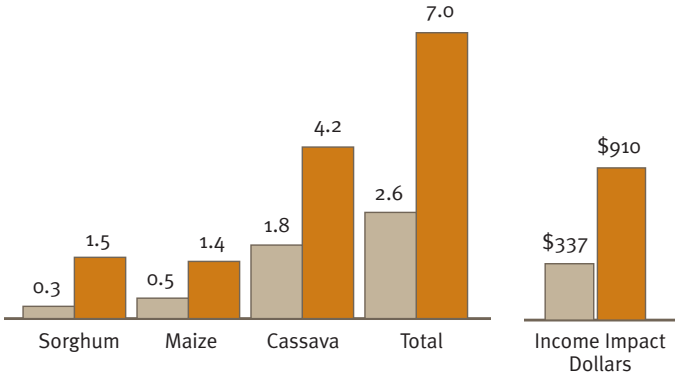
The Gates Foundation has a strong specific focus on gender issue sensitivity in its efforts to effectively support women farmers as a mainstream part of reaching all small-holder farmers.

The Gates Foundation focuses on improving the major crops that poor farmers grow and poor consumers eat, and on narrowing the yield gap between what is realized today on the farm and what is possible using the best locally relevant practices and crop varieties. With these improvements, it should be possible to double or triple, the productivity and the income for most subsistence farmers, because they use such low productivity practices today.

The problems that poor farmers face are numerous and complex. The Foundation strives to identify the big ones and to focus mostly on what simple tools will most effectively help boost small-holder productivity. We are also pursuing a strategy to encourage the development of markets, while recognizing that one of the reasons poverty is so persistent is that market failures are abundant in these areas of the world. "Market failures" is not a pejorative term; it is an economic term to describe markets that are not efficiently meeting societal needs. There are many very rational, understandable, reasons why market failures occur. It is not because markets are behaving badly. In fact, most market failures occur when markets are behaving rationally and properly. In many situations where market failures occur, it is because the solution is not market relevant, such as with orphan crops. These are the true-breeding crops, where seed can be saved, so there is no incentive to invest in private breeding. The Foundation endeavors to respect markets, identify market failures, and then invest in the public goods to compensate where markets are not serving the needs of the poor.

The Bill & Melinda Gates Foundation is addressing sustainable productivity growth as the most direct objective of our development goals. We are working through the value chains for the most important crops and livestock. Relevant to the philosophy of the Riley Foundation, we are focused

**Agricultural Development Goals at a Farmer Level**




Bill and Melinda Gates Foundation Analysis

heavily on working in partnerships. I would like to mention three of our guiding principles. First, which is also at the forefront of the Riley philosophy, is to work very closely in partnership with a multitude of people and institutions. Second and something I learned from NSF, is the value of peer review: all of our grants go out for extensive peer review before they are finalized and awarded. And third, is our continued focus on women farmers.

Increasing productivity is a means to achieving the ends of reduced hunger, improved nutrition, and healthy, productive lives. Focusing on a handful of countries in Africa, Bangladesh and the Indian states of Bihar and Orissa, we are investing in public goods varieties of commodity crops, using partnerships and working with these countries and their national agricultural programs to deliver the resulting products. We invest in the global systems like the CGIAR system and in global products, such as the major crop breeding programs to address very important traits like drought tolerance, disease resistance or vaccines for livestock. We also invest in the national agricultural research systems, in national public goods, and in delivery and adoption of improved products and services at scale.

Historically, the returns on agriculture research have been quite high across all regions of the world. We are targeting three big outcomes from agricultural research and development: improved productivity of crops and livestock, improved nutrition, and decreased risk to farmers. The nutrition work focuses on vitamin A (beta-carotene), iron and zinc enhancements in staple crops. One example is golden rice, which has elevated levels of beta-carotene, which turns it a golden yellow color.

The most important crops in Africa include maize, sorghum, millet, rice, cassava, cowpeas, and groundnuts. In South Asia the most important crops are rice, wheat, millet, maize, sorghum, and beans. For these target crops we identify the areas where research can improve productivity: better management practices, resistance to biotic stresses such as disease and weeds, and abiotic stresses like drought or nutrient stresses. In addition, we identify socio-economic improvements that are necessary to enable farmers to access and benefit from increases in productivity.

I would like to describe a few specific examples of what we are doing. One is a grant that funds a large partnership between the International Rice Research Institute (IRRI), Africa Rice Center (WARDA), the Indian Council of Agricultural Research (ICAR), as well as several universities. Last year, Pam Ronald delivered the Riley lecture and spoke about her work on submergence tolerance in rice. The Foundation funded a project to apply the results of her work, translating the scientific understanding of this trait and its inheritance into more valuable finished varieties of rice. The grant also funded field testing, seed bulking, and delivery of the new seed at scale. Last year, the new varieties were deployed on more than a million hectares and are predicted to reach another ten to twenty million hectares of use this decade in the form of several dozen different varieties that contain the introgressed sub1 allele. This is a non-transgenic product. Molecular biology was used to

understand the phenomenon, to identify the gene, and to aid breeders in moving the gene through a traditional backcrossing approach.

Drought-tolerant maize for Africa is a similar product that is being breed in a cooperative undertaking by Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) in Mexico and the International Institute of Tropical Agriculture (IITA) in Nigeria. Drought is one of the major productivity-limiting and risk-inducing factors in African maize. And this project is part of a broader program, involving the African Cultural Technology Foundation, CIMMYT, and Monsanto Company, to apply conventional breeding, marker-assisted breeding and transgenic approaches to drought-tolerance in maize. Both conventional and transgenic product lines are anticipated from this research. The beauty of applying all of the available approaches is that they may be additive; each could bring a benefit that when combined acts synergistically to yield an even greater benefit than using one technology alone. We have a similar partnership that involves CIMMYT, Pioneer Company and the national programs in South Africa and Kenya to look at nitrogen use efficiency in maize. This also could have both conventional and transgenic outputs in the long run.

We have recently launched a program in livestock. There are almost a billion poor livestock holders in Africa and South Asia, and the demand for animal products is going to rise faster than the demand for basic cereal calories. As people's income increases, they want to move up the food chain, resulting in greater increases in consumer demand for livestock than for human consumption of cereal grains and legumes. Our livestock focus is cattle, chickens goats and sheep. We are targeting livestock health, including animal vaccines, genetics and reproduction, and post-harvest value addition.

Even though the Gates Foundation strongly supports innovation in science and technology, that is not an end in itself, and it does not drive how we make decisions about the best ways to enable people to lead healthy and productive lives. For instance, within the agricultural development portfolio, about six percent of our grant money supports transgenic research and product development but this was not a policy decision, we did not say, "Six percent sounds right." It was a pragmatic outcome from asking, "What is the best tool for the tasks that we have prioritized?" I expect this number will go up over time as more becomes possible using biotechnology and as regulatory and acceptance barriers are reduced.

Sometimes we recognize that innovation is needed, but we don't know what type of innovation so we do what we call "innovation prospecting." This can take a variety of forms. For instance, we have collaborated with the National Science Foundation on the Basic Research to Enable Agricultural Development (BREAD) Program. This competitive grants program brings together the best U.S. scientists, usually in collaborative partnership with developing country scientists, to find agriculture or plant science problem solutions that will lead to improved applications for

development. We have a similar partnership with the Biotechnology and Biological Sciences Research Council (BBSRC), which is co-funded by the Department for International Development (DFID), the UK equivalent to USAID. Most recently, we have launched our Grand Challenge Exploration Program to solicit innovative ideas. It requires only a two-page application and awards $100,000 grants to projects aimed at solving specific problems in agriculture.

Thank you.

# Federal Food, Nutrition, Agriculture and Natural Resource Sciences Funding Update

**Matt Hourihan**
Director, R&D Budget and Policy Program
American Association for the Advancement of Science

Amid a difficult fiscal environment, the U.S. Department of Agriculture (USDA) is facing another potential year of reduced funding for its research and development (R&D) portfolio. These potential reductions are due in part to the moratorium on earmarks and in part to continued efforts to reduce federal spending; this is exacerbated by the threat of sequestration, which could levy an across-the-board cut of approximately 8 percent. In FY 2012, USDA R&D received a $34 million (1.4 percent) cut, not including a $230 million rescission of prior-year appropriations from the Agricultural Research Service. Congressional action on the FY 2013 budget has been somewhat limited, as neither chamber has held a floor vote on the Agriculture spending bill at the time of this writing. The Senate Appropriations Committee bill would keep the ARS budget largely unchanged from last year; the National Institute of Food and Agriculture (NIFA) would receive a $19 million (2.6 percent) cut from FY 2012, but the Agriculture and Food Research Initiative (AFRI) would receive a boost of $33 million (12.7 percent). The House Appropriations Committee's bill is less generous, with ARS and NIFA subject to cuts of varying degrees, and AFRI receiving a much smaller increase than the Administration had sought.

Other food, nutrition, agriculture, and natural resource related agencies show a mixed funding record. The National Science Foundation has fared well in recent appropriations cycles and continues to do so, while the National Institutes of Health have been facing years of flat or declining budgets, and the Department of Energy's Office of Science is facing a year of flat budgets or small reductions after steady growth earlier in the decade.

# Federal Food, Nutrition, Agriculture, and Natural Resource Science Investments

(budget authority in millions of dollars)

| | FY 2011 Actual | FY 2012 Estimate | Change FY 11-12 Amount | Change FY 11-12 Percent | FY 2013 Budget | FY 2013 House** | Change FY 12-13 Amount | Change FY 12-13 Percent | FY 2013 Senate** | Change FY 12-13 Amount | Change FY 12-13 Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Selected USDA Program R&D*** | | | | | | | | | | | |
| Agricultural Research Service (ARS)* | 1,164 | 1,126 | -38 | -3.3% | 1,131 | 1,101 | -25 | -2.2% | 1,130 | 4 | 0.4% |
| Natl Inst of Food & Agri (NIFA) | 738 | 750 | 12 | 1.6% | 709 | 659 | -91 | -12.1% | 731 | -19 | -2.6% |
| Agri & Food Research Init (AFRI) | 264 | 264 | 0 | 0.0% | 325 | 277 | 13 | 4.7% | 298 | 33 | 12.7% |
| Forest Service | 346 | 334 | -12 | -3.5% | 330 | 281 | -53 | -15.9% | - - | - - | - - |
| Forest and Rangeland Research | 334 | 324 | -10 | -3.0% | 321 | 272 | -52 | -16.2% | - - | - - | - - |
| **U.S. Dept of Agriculture R&D*** | 2,365 | 2,331 | -34 | -1.4% | 2,297 | 2,180 | -151 | -6.5% | 1,984 | -347 | -14.9% |
| **Other Related Agencies (Includes Non-R&D Components)** | | | | | | | | | | | |
| National Institutes of Health | 30,767 | 30,702 | -65 | -0.2% | 30,702 | 30,698 | -4 | 0.0% | 30,801 | 99 | 0.3% |
| National Science Foundation | 6,913 | 7,033 | 121 | 1.7% | 7,373 | 7,333 | 299 | 4.3% | 7,273 | 240 | 3.4% |
| Dept of Energy - Office of Science | 4,897 | 4,874 | -24 | -0.5% | 4,992 | 4,801 | -72 | -1.5% | 4,909 | 35 | 0.7% |

Source: AAAS estimates based on OMB R&D data, agency budget documents, and Congressional reports.

Notes: Figures do not include prior year rescissions. Figures include both appropriated funding and non-appropriated funding streams.

*Does not include $230 million rescission to ARS facilities in FY 2011.

**Some figures refer to Appropriations Committee bills.

# Food, Nutrition, Agriculture, and Natural Resource Sciences in the FY 2013 Budget

**Excerpt from the "AAAS Report XXXVII: Research and Development FY 2013"**
Visit http://www.aaas.org/spp/rd/rdreport2013/ to read the full report.

**Sarah Ohlhorst**
American Society for Nutrition

**William Fisher**
Institute of Food Technologists

**Karl Anderson and Karl Glasener**
American Society of Agronomy, Crop Science Society of America, Soil Science Society of America

**Lowell Randel**
Federation of Animal Science Societies

**Karen Mowrer**
Federation of American Societies for Experimental Biology

**Jim Gulliford**
Soil and Water Conservation Society

**HIGHLIGHTS**

- Current budgetary constraints have flat-funded or decreased funding for the majority of R&D programs in the food, nutrition, agriculture, and natural resource sciences. Research agencies continue to focus funds and leverage resources to ensure effective solutions for their identified challenge areas and strategic plan goals, including designated research projects.

- Congress and the Administration have made commitments to strengthen food safety, as evidenced by passage of the Food Safety Modernization Act (FSMA) and significant increases proposed for the Food and Drug Administration (FDA)'s food safety budget. Significant increases above FY 2012 funding levels were also proposed for the U.S. Department of Agriculture National Institute of Food and Agriculture (NIFA)'s Agriculture and Food Research Initiative competitive grants program and the Department of Energy (DOE)'s Biomass and Biorefinery Systems R&D program.

# Table 1 Food, Nutrition, Agriculture and Natural Resources Science in the FY 2013 Budget (budget authority in millions of dollars)

| | FY 2011 Actual | FY 2012 Estimate | FY 2013 Budget | Change FY 11-13 Amount | Percent |
|---|---|---|---|---|---|
| **US Dept of Agriculture Program R&D** | | | | | |
| **NIFA 1/** | | | | | |
| Food Safety | 53 | 44 | 42 | -11 | -20.8% |
| Food Security | 24 | 39 | 46 | 22 | 91.7% |
| Natural Resources | 49 | 34 | 34 | -15 | -30.6% |
| Nutrition | 158 | 112 | 120 | -38 | -24.1% |
| Renewable Energy 2/ | 120 | 75 | 62 | -58 | -48.3% |
| **ARS** | | | | | |
| Food Safety | 108 | 106 | 108 | 0 | 0.0% |
| Food Security | 144 | 140 | 137 | -7 | -4.9% |
| Natural Resources | 201 | 189 | 214 | 13 | 6.5% |
| Nutrition | 85 | 85 | 84 | -1 | -1.2% |
| Renewable Energy | 33 | 33 | 33 | 0 | 0.0% |
| **ERS** | | | | | |
| Food Safety | 1 | 1 | 1 | 0 | 0.0% |
| Food Security | 4 | 4 | 4 | 0 | 0.0% |
| Nutrition | 16 | 15 | 15 | -1 | -6.3% |
| Renewable Energy | 2 | 2 | 2 | 0 | 0.0% |
| **Forest Service** | | | | | |
| Natural Resources | 67 | 64 | 67 | 0 | -0.3% |
| Renewable Energy | 13 | 13 | 13 | 0 | 0.0% |
| **Dept of Health and Human Services** | | | | | |
| **FDA** | | | | | |
| Food Safety | 1,175 | 1,172 | 1,425 | 250 | 21.3% |
| **NIH** | | | | | |
| Food Safety | 287 | 286 | 287 | 0 | 0.0% |
| Nutrition | 1,411 | 1,389 | 1,386 | -25 | -1.8% |
| Nutrition-Obesity | 830 | 829 | 827 | -3 | -0.4% |
| **Dept of Energy** | | | | | |
| Bioenergy | 180 | 199 | 270 | 90 | 50% |
| **U.S. Geological Survey** | | | | | |
| NAWQA | 67 | 63 | 56 | -10 | -15.3% |
| COOP Water Program | 66 | 64 | 59 | -7 | -9.9% |

Source: Agency budget justifications and other budget documents. All figures rounded to the nearest million.
Changes calculated from unrounded figures. 1/ Includes portion of AFRI funding that supports Education and Extension.
2/ Includes Mandatory Farm Bill funding for Biomass Research and Development Initiative.

## INTRODUCTION

Agricultural research is crucial to provide a safe, nutritious, affordable, and sustainable food supply for the growing world population; to preserve the competitive position of U.S. agriculture; and to provide jobs and revenue to support the U.S. economy. Agricultural research builds knowledge necessary to solve current and future challenges in many areas including animal and human health, food safety and security, and energy and the environment. In 2006, agricultural products and services contributed $121 billion to U.S. gross domestic product (GDP), supported 2.2 million jobs, and contributed $20 billion in net annual exports. Food manufacturing supplied $160 billion of the U.S. GDP and 1.7 million jobs. Even so, support for U.S. agricultural R&D has been flat-funded since 2001 while state funding has precipitously declined.

## FOOD SAFETY

R&D funding for food safety primarily resides within the USDA and Department of Health and Human Services (HHS), specifically within the FDA. The largest portion of USDA's food safety R&D is found in the Agricultural Research Service (ARS), USDA's in-house scientific research agency, and NIFA, USDA's major extramural research agency.

NIFA's requested food safety budget across all programs is decreased slightly in FY 2013 to $42 million. Base funding would support ongoing research, education, and extension to improve the safety of the U.S. food supply through new and improved rapid detection methods, pre- and post-harvest epidemiological studies, and improved harvesting and processing technologies. Increased funding in FY 2013 for the Food Safety Challenge Area would support work to: 1) minimize antibiotic resistance transmission through the food chain, and 2) minimize microbial safety hazards of fresh and fresh-cut fruits and vegetables.

ARS' current food safety research is designed to yield science-based knowledge on the safe production, storage, processing, and handling of plant and animal products, and on the detection and control of toxin producing and/or pathogenic bacteria and fungi, parasites, chemical contaminants, and plant toxins. The FY 2013 budget proposes to reallocate $4.1 million for research to develop specific post-harvest pathogen reduction strategies while ensuring that these treatments do not adversely impact product quality. The President's proposed budget also includes a reallocation of $1.1 million to develop and evaluate alternatives to antibiotics in food animals, as well as to evaluate the role of management practices and the environment on the prevalence of antimicrobial resistance and emerging pathogens in food animals.

The USDA Economic Research Service (ERS) FY 2013 budget of $1.5 million is the same as was allocated in FY 2012. Food safety research at ERS focuses on investigating the safety of food imports and the efficacy of international food safety policies and practices; enhancing methods for

understanding the benefits associated with reduced food safety risks; consumer willingness to pay for safer food; assessment of industry incentives to enhance food safety; and evaluation of regulatory options.

FDA research includes development of rapid detection and confirmatory methods, as well as investigations in biotechnology, virology, in vitro testing, and laboratory enhancement. A majority of FDA's food safety research is performed by the Center for Food Safety and Applied Nutrition. External research centers include the Joint Institute for Food Safety and Applied Nutrition, the National Center for Food Safety and Technology, and the Western Institute for Food Safety and Security. FDA's Transforming Food Safety and Nutrition Initiative requested an increase of $253 million over FY 2012 to continue to implement the Food Safety Modernization Act by establishing a prevention-focused food safety system while leveraging state and local partners.

Also within HHS, the National Institutes of Health (NIH) has budgeted $287 million for food safety in FY 2013, the same level as in 2011 and 2012. The National Institute of Allergy and Infectious Diseases (NIAID) is one of several NIH institutes that conducts and supports research related to food safety, although NIAID research accounts for the majority of NIH's $287 million food safety budget. Examples of NIAID food safety research include: susceptibility to infection, efficacy of vaccines, development and evaluation of antibody-based treatments, and the advanced development of promising biodefense products.

**FOOD SECURITY**

The term "food security" can apply to both domestic and global food needs. Research on domestic food security – access to adequate food to lead an active, healthy life – is conducted primarily by the USDA Research, Education, and Economics (REE) Mission Area, whereas both USDA REE and the U.S. Agency for International Development (USAID) play important roles in global food security.

Food security is an important component of USDA programs and is specifically highlighted in the department's Strategic Plan. The third goal in the plan is entitled, "Help America promote agricultural production and biotechnology exports as America works to increase food security." The USDA NIFA FY 2013 request proposes $46 million for efforts to improve food security through the Agricultural Food and Research Initiative (AFRI). This represents a $7 million increase over FY 2012 to support competitive grants related to food security.

The FY 2013 ARS budget includes $137 million for food security, a $3 million reduction from 2012. Within the overall ARS budget, the Animal Production and Protection and Crop Production and Protection National Programs support food security research in many areas with special emphasis on crop and livestock production. ARS's animal, insect, plant, and microbial germplasm collections within the National Plant Germplasm System provide an essential reservoir of genetic diversity and

traits useful in overcoming abiotic and biotic stresses in production. The FY 2013 request includes a reallocation of $4.1 million for improved animal protection research which would enhance food production and security. The budget also includes a reallocation of $7.6 million for research to enhance plant health by developing management tools for soil-borne plant pathogenic microbes and nematodes.

The President requests $4 million in the ERS budget for activities related to food security, the same funding as FY 2012. The National Science Foundation (NSF) Biological Sciences (BIO) Directorate's Division of Integrative Organismal Systems (IOS) supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems interacting with their environments. The President's FY 13 budget request includes a 3.9 percent increase for IOS bringing total funding to $220.5 million, which would allow 41 percent of the IOS portfolio to be available for new research grants. The Plant Genome Research Program (PGRP) is critical to genome-wide investigations that support biotech development. The PGRP's Basic Research to Enable Agricultural Development (BREAD) Program supports basic research on early-concept approaches and technologies for science-based solutions to problems of agriculture in developing countries. In FY 2013, NSF requests $6 million for the BREAD program.

The FY 2013 request for USAID's Feed the Future (FtF) Initiative is $1 billion. In FY 2012, $145 million was designated within the Feed the Future initiative for R&D. The amount designated for R&D in FY 2013 has not yet been determined. USAID also supports the Consultative Group on International Agricultural Research (CGIAR) program, an essential component of global long-term agricultural R&D, and the Collaborative Research Support Programs (CRSP). FY 2013 budget details for CGIAR and CRSP also have not yet been designated.

**NATURAL RESOURCES**

Multidisciplinary research is essential to the development of resource management practices and technologies to address agricultural sustainability and natural resource protection issues.

The President has proposed a $25 million increase to support ARS Natural Resources and Sustainable Agricultural Systems research in soil, water and air resources, rangelands, pastures and forage systems. Of the increase, $9.5 million will enhance ARS research on watersheds and rangelands and strengthen the network of Long-Term Agro-Ecosystem Research (LTAR) sites to improve the link between ARS LTAR and the NSF National Ecological Observatory Network. This linked network will support research on agricultural production systems and ecosystem services produced in agricultural landscapes.

ARS will develop three key platforms ($5 million increase) to support research to improve corn, rice and wheat germplasm for yield, drought tolerance, heat and cold tolerance and improved nutrient efficiency. Research will utilize USDA's new high-throughput 3-D imaging to identify genetic

components for root system architecture, physiology, and acquisition of limiting resources including water and nutrients.

Priority natural resource research at the Economic Research Service includes the Economics of Markets for Agricultural Greenhouse Gases that apply directly to markets for ecosystem services. The overall request for 2013 of $77.4 million is slightly less than 2012 enacted.

At NIFA, the President has proposed a $61 million increase for AFRI competitive grants. Among the critical issues addressed through AFRI are sustainable bioenergy, natural resources and the environment, and climate change. The NIFA Crop Protection Program ($29.1 million) supports research to respond to pest management challenges and the development of integrated pest management approaches.

The USDA Forest Service conducts forest and rangelands research directed toward sustaining healthy watersheds, forest products, and other forest benefits. The President's 2013 budget request is $292.8 million, $2.5 million less than 2012 enacted.

The U.S. Geological Survey National Water-Quality Assessment Program combines nationally comprehensive and systematic, long-term water-quality monitoring of nutrients, sediment, pesticides, and other contaminants in surface and groundwater with the goal of providing the understanding of conditions, trends, and decision support tools needed to improve water-quality management. The proposed funding for NAWQA is $56.3 million, a $6.3 million reduction. The USGS Cooperative Water Program supports more than 700 interpretative and research studies annually in partnership with local, state, and tribal agencies and provides support for nearly 6,000 of the nation's stream gages. The proposed FY 2013 funding for the Cooperative Water Program is $59 million, a $5 million reduction from FY12 enacted.

The U.S. Environmental Protection Agency FY 2013 budget request for the Office of Research and Development includes $121.2 million ($7.7 million increase) support for Safe and Sustainable Water Resources. Building upon ongoing research and collaboration with DOE and USGS, a $14 million investment will begin to assess potential impacts of hydraulic fracturing on air and water quality, and ecosystems.

**NUTRITION AND OBESITY**

NIH funds approximately 86 percent of public sector nutrition research, followed by USDA. In FY 2013, NIH estimates it will award $1.4 billion in grants for nutrition-related research, with $827 million funding obesity-related research. Although many NIH institutes and centers invest in nutrition R&D, the National Institute of Diabetes and Digestive and Kidney Diseases, the National Heart, Lung and Blood Institute, and the National Cancer Institute are the lead contributors, accounting for about 60 percent of NIH nutrition-related spending. NIH funded nearly 4,300 nutrition research projects in

FY 2011, about 900 fewer than in FY 2010. Many of these projects investigate implications of nutrition for chronic diseases. For example, the FY 2013 budget requests $5 million for the Vitamin D for Type 2 Diabetes Trial, a multicenter study to test whether vitamin D can prevent or delay onset of type 2 diabetes in high-risk adults. Last year, the NIH Obesity Research Task Force released a new strategic plan, recommending that researchers examine the obesity epidemic by addressing a diverse set of scientific questions.

At USDA, the FY 2013 ARS Human Nutrition Research Program budget request is $84 million, including a proposed reallocation of $2.9 million to strengthen nutrition monitoring programs, which have been flat-funded for a decade. These funds would improve USDA's food composition databases and link national food consumption survey data with the Dietary Guidelines for Americans. ARS has increased its emphasis on obesity prevention by funding basic research, intervention studies, and large-scale assessments on the topic. The six ARS Human Nutrition Research Centers leverage resources through partnerships with federal agencies, universities, and commodity groups.

Also at USDA, NIFA requests $120 million for nutrition-related research, education, and extension activities in FY 2013. These include AFRI's Food Safety, Nutrition, and Health Foundational Program and the Childhood Obesity Prevention Challenge Area. In FY 2011, the challenge area funded research on children ages 2-14 years; $5 million made available in FY 2012 and $7.2 million in FY 2013 would support new research awards to study children ages 2-19 years.

USDA's ERS budget was reduced by 5 percent in FY 2012, negatively impacting investments in food consumption data collection. In FY 2013, ERS nutrition funding would remain unchanged, and resources provided to ERS by other federal agencies would be constrained. Despite limited budgets, last year ERS introduced the Food Desert Locator, an online mapping tool that supports work of the interagency Healthy Food Financing Initiative as part of the First Lady's Let's Move! initiative.

At the Centers for Disease Control and Prevention (CDC), the National Center for Health Statistics administers the National Health and Nutrition Examination Survey, but in FY 2013 other nutrition-related activities will be consolidated into the Coordinated Chronic Disease Prevention and Health Promotion Program. NIH, USDA, CDC, and the Robert Wood Johnson Foundation work to improve the efficiency, effectiveness, and application of childhood obesity research, as members of the National Collaborative on Childhood Obesity Research.

**RENEWABLE ENERGY**

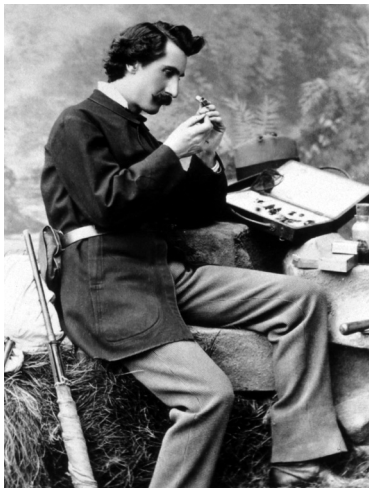
The Biofuels Interagency Working Group is co-chaired by the Secretaries of the DOE, USDA, and the EPA Administrator. These agencies perform basic and applied research for the genetic development of biomass, sustainable production of feedstocks, logistics, and biomass conversion into advanced biofuels and value-added co-products.

The goal of the DOE Biomass and Biorefinery Systems R&D program is to ensure that cellulosic ethanol is cost-competitive by 2013. A total of $270 million has been requested for the Biomass Program, marking a significant increase over FY 2012. Within DOE SC's Office of Biological and Environmental Research (BER), the Genomic Science Program (GS) receives a small ($4.1 million) increase, bringing the total request to $188.1 million for FY 2013. While the Bioenergy Research Centers received no increase (request is $75 million for FY 2013), the Joint Genome Institute (JGI) receives a small increase of $0.7 million in the budget request. The JGI is an essential infrastructural component which uses tools from contemporary systems biology to understand and predict the energetic relationships between microbes and plants. The increase would support synthetic molecular toolkits that predict, design, construct, and test new biological systems for clean energy solutions.

The USDA NIFA FY 2013 budget request for the alternative and renewable energy research initiative is $30 million. DOE and USDA NIFA jointly administer the Plant Feedstock Genomics for Bioenergy and the Biomass Research and Development Initiative (BRDI) to advance fundamental understanding of lignocellulosic biomass accumulation and other traits relevant to fuel production. There is no budget requested for BRDI in FY 2013, as the mandatory program must be reauthorized in the next Farm Bill. For FY 2012, BRDI was funded at $40 million. NIFA also contains AFRI's Sustainable Bioenergy Challenge Area program which funds research on carbon sequestration, biomass feedstock protection, and utilization of co-products. Finally, the FY 2013 budget includes a request of $13 million for research on sustainable and efficient production, harvest, and conversion of liquid fuels, chemicals, and other high-value products within the USDA Forest Service R&D Bioenergy and Biobased products investment.

**ACKNOWLEDGEMENTS**
Emily Konopka and Caitlin Hickey

# About Charles Valentine Riley



*Charles Valentine Riley Examining an Insect.* Undated. Charles Valentine Riley Collection. Special Collections, National Agricultural Library, Beltsville, Maryland. http://www.nal.usda.gov/speccoll/.

**Charles Valentine Riley (1843-1895)**

"Professor Riley," as he was generally known, was born in Chelsea, London, England, on September 19, 1843. He attended boarding school at Dieppe, France, and Bonn, Germany. Passionately fond of natural history, drawing, and painting, he collected and studied insects and sketched them in pencil and in color. At both Dieppe and Bonn, he won prizes in drawing and was encouraged to pursue art as a career.

At the age of 17, he came to the United States and settled on an Illinois farm about 50 miles from Chicago. Soon his attention was drawn to insect injuries of crops, and he sent accounts of his observations to the *Prairie Farmer.* At the age of 21, Riley moved to Chicago and worked for this leading agricultural journal as a reporter, artist, and editor of its entomological department. His writings attracted the attention of Benjamin D. Walsh, the Illinois State entomologist. It was through Walsh's influence as well as the recommendation of N.J. Coleman of *Coleman's Rural World* that Riley was appointed in the spring of 1868 to the newly created office of entomologist of the State of Missouri. From 1868 to 1877, in collaboration with T. W. Harris, B. D. Walsh, and Asa Fitch, Riley published nine annual reports as State Entomologist of Missouri, which unequivocally established his reputation as an eminent entomologist. Today, authorities agree that these nine reports constitute the foundation of modern entomology.

From 1873 to 1877, many Western States and territories were invaded by grasshoppers from the Northwest. In some states their destruction of crops was so serious that it caused starvation among pioneer families. Riley studied this plague and published results in his last three Missouri annual reports and worked to bring it to the attention of Congress. In March 1877, he succeeded in securing passage of a bill creating the United States Entomological Commission, the Grasshopper Commission administered under the Director of the Geological Survey of the U. S. Department of the Interior. Riley was appointed chairman, A. S. Packard, Jr., secretary, and Cyrus Thomas, treasurer.

All this time, Riley, with the help of Otto Lugger, Theodore Pergrande, and others, was also making brilliant contributions to the knowledge of the biology of insects. Besides studying the life cycles of the 13 and 17 year cicadas, he also studied the remarkable *Yucca* moth and its pollination of the *Yucca* flower, a matter of special evolutionary interest to Charles Darwin. In addition, he conducted intensive life history studies of blister beetles and their unusual triungulin larvae, and the caprification of the fig.

In the spring of 1878, Townend Glover retired as entomologist to the U. S. Department of Agriculture and Riley was appointed his successor. After a year in this position, Riley resigned owing to a

disagreement with the Commissioner of Agriculture over Riley's practice of making independent political contacts; he then continued the work of the U. S. Entomological Commission with others, from his home. Two years later, after the inauguration of President James A. Garfield in 1881, Riley was reappointed and remained chief of the Federal Entomological Service until June 1894, when the Service was renamed the Division of Entomology of the U.S. Department of Agriculture. In 1882, Riley gave part of his insect collection to the U. S. National Museum, now The Smithsonian Institution, at which time he was made honorary curator of insects. In 1885, he was appointed assistant curator of the Museum, thus becoming the Museum's first curator of insects, whereupon he gave the Museum his entire insect collection consisting of 115,000 mounted specimens (representing 20,000 species), 2,800 vials, and 3,000 slides of specimens mounted in Canadian balsam.

One of Riley's greatest triumphs while Chief of the Federal Entomological Service was his initiation of efforts to collect parasites and predators of the cottony cushion scale, which was destroying the citrus industry in California. In 1888, he sent Albert Koebele to Australia to collect natural enemies of the scale. A beetle, *Vedalia cardinalis,* now *Rodolia cardinalis,* was introduced into California and significantly reduced populations of the cottony cushion scale. This effort gave great impetus to the study of biological control for the reduction of injurious pests and established Charles Valentine Riley as the "Father of the Biological Control." For a review of the cottony cushion scale project, see Doutt, 1958.

A prolific writer and artist, Riley authored over 2,400 publications. He also published two journals, the *American Entomologist* (1868-80) and *Insect Life* (1889-94). Riley received many honors during his lifetime. He was decorated by the French Government for his work on the grapevine *Phylloxera*. He received honorary degrees from Kansas State University and the University of Missouri. He was an honorary member of the Entomological Society of London and founder and first president of the Entomological Society of Washington. He and Dr. L. O. Howard, Riley's assistant in the Federal Entomological Service, were among the founders of the American Association of Economic Entomologists, which became part of Entomological Society of America in 1953.

Tragically, on September 14, 1895 Riley's life was cut short by a fatal bicycle accident. As he was riding rapidly down a hill, the bicycle wheel struck a granite paving block dropped by a wagon. He catapulted to the pavement and fractured his skull. He was carried home on a wagon and never regained consciousness. He died at his home the same day at the age of 52, leaving his wife with six children.

**ACKNOWLEDGEMENTS**

We would like to thank the U.S. Department of Agriculture, National Agricultural Library (NAL) for providing Riley's biographical information and accompanying image. The Charles Valentine Riley Collection at NAL includes correspondence, unpublished lectures, photographs, news clippings, drawings, reprints, books, and artifacts covering the time period from 1868 to 1919.

# About the Lecture and Partner Organizations

In 2008, the Charles Valentine Riley Memorial Foundation (RMF) selected the American Association for the Advancement of Science (AAAS) to receive an endowment to establish the annual AAAS Charles Valentine Riley Memorial Lecture "to promote a broader and more complete understanding of agriculture as the most basic human endeavor and ... to enhance agriculture through increased scientific knowledge."

A partnership between RMF, AAAS, and the World Food Prize Foundation (WFPF) was then formed to implement the annual lecture. Collaboration among AAAS, RMF, and WFPF provides a unique opportunity to build upon Charles Valentine Riley's legacy as a "whole picture" person with a vision for enhancing agriculture through scientific knowledge. Professor Riley's involvement with AAAS, beginning as a member in 1868, being elected a Fellow in 1874, and serving as Vice President for the biology section in 1888, brings into the perspective his view of how science affects agriculture when placed in the broadest context.

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

**The American Association for the Advancement of Science (AAAS)**
The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society and publisher of the journals *Science* (www.sciencemag.org), *Science Signaling* (www.sciencesignaling.org), and *Science Translational Medicine* (www.sciencetranslationalmedicine.org). AAAS was founded in 1848, and serves 262 affiliated societies and academies of science, reaching 10 million individuals. The nonprofit is open to all and fulfills its mission to "advance science and serve society" through initiatives in science policy, international programs, science education, and more. More information on AAAS and its diverse portfolio of activities can be found at www.aaas.org.

**Charles Valentine Riley Memorial Foundation**

The Charles Valentine Riley Memorial Foundation (RMF) is committed to promoting a broader and more complete understanding of agriculture and to building upon Charles Valentine Riley's legacy as a "whole picture" person with a vision for enhancing agriculture through scientific knowledge. Founded in 1985, RMF recognizes that agriculture is the most basic human endeavor and that a vibrant, robust, food, agricultural, forestry, and environmental-resource system is essential for human progress and world peace. RMF conducts a wide range of program activities that include discussion groups, forums, round tables, workshops, briefing papers, and lectures on various parts of the food, agricultural, forestry, and environmental-resource system. RMF's goal is to have all world citizens involved in creating a sustainable food and agriculture enterprise within a responsible rural landscape. More information is available at www.rileymemorial.org.

**World Food Prize Foundation**

Founded by Nobel laureate and "Father of the Green Revolution" Dr. Norman E. Borlaug, the World Food Prize is a $250,000 award presented annually for breakthrough achievements in science, technology, and policy that have improved the quality, quantity, and availability of food in the world. Termed "the Nobel Prize for Food and Agriculture" by several heads of state, it is presented each October in conjunction with a week of events that includes the international "Borlaug Dialogue" symposium and gathers pre-eminent global leaders and experts representing over 65 countries. The 2012 World Food Prize events will take place October 17 to 19 in Des Moines, Iowa. Information about the World Food Prize events, highlights from past Borlaug Dialogue symposia, and nomination criteria are available at www.worldfoodprize.org.